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ABSTRACT

This workbook is the second in a series of three that has been integrated into the chemistry curriculum for majors at the University of Vermont. The workbook, which consists of exercises designed to provide undergraduate students with foundation skills in the use of professional literature, is introduced late in a second semester organic chemistry course. Each exercise consists of discussion material and instructions and a fill-in worksheet. Exercise topics focus on: (1) "Beilsteins Handbuch der organischen Chemie," the most comprehensive and useful reference handbook in organic chemistry; (2) the Beilstein classification system; (3) the Beilstein indexes; (4) locating references; (5) resource materials for Beilstein users; (6) other English language handbooks; and (7) organic preparation in "Chemical Abstracts." A list of references and a 6-item student evaluation sheet are included. (JN)

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AN INTRODUCTION TO THE LITERATURE OF ORGANIC PREPARATIONS

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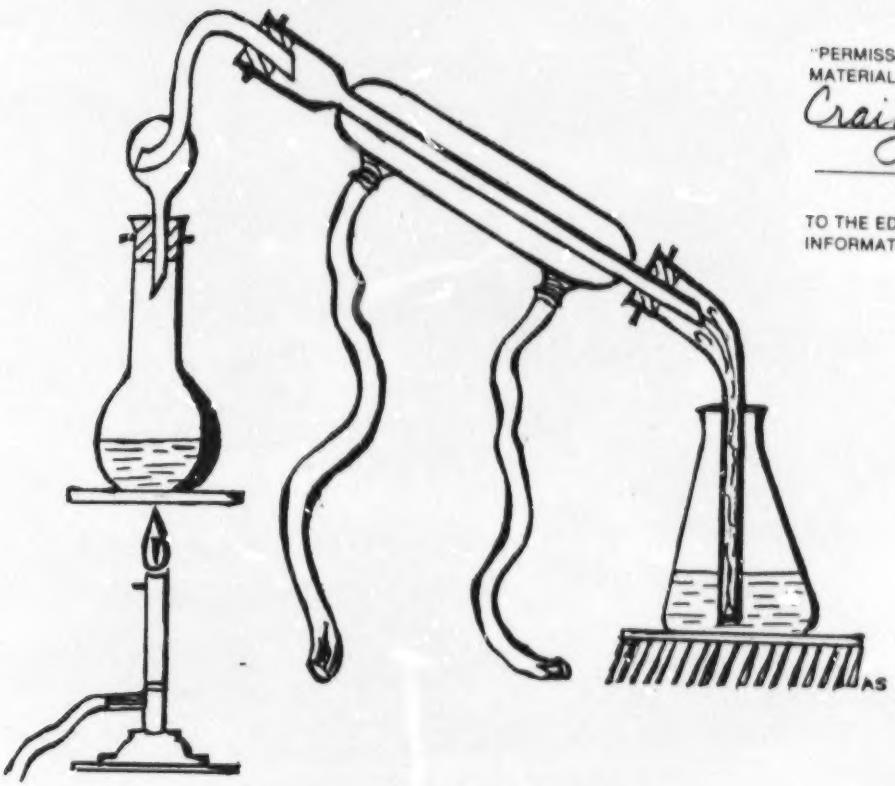

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BY:
CRAIG A. ROBERTSON

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AN INTRODUCTION TO THE LITERATURE OF ORGANIC PREPARATIONS

Pro Willelmo Aibo
Magister litteris chimicis peritior

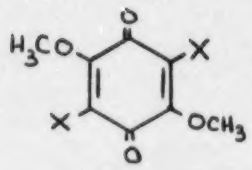
With thanks to Dr. William N. White
and to Mr. John J. Landi,
Department of Chemistry, UVM

Dear Reader:

This workbook is the second in a series that we have integrated into the chemistry curriculum for majors at the University of Vermont in order to train undergraduates in the use of professional literature. This specific workbook is introduced late in the second semester of a B.S.-track laboratory course in Organic Chemistry, at a time when students are expected to show considerable independence in design and execution of a multi-step project in preparative chemistry.

The workbook makes use of multiple sets of fill-ins (one set is included for illustration) to encourage students to work independently. It assumes that each student has completed an earlier workbook: An Introduction to Chemical Abstracts.

FILL-IN SHEET No._____

1. 

2. 4,4,4-trichlorobutene-2-amide

3. Beil. 9(3)2262

4. 3-thiophenecarboxylic acid

5. 1-H-indole-3-acetic acid

6. 2,4-dinitrophenol

6a. 4-ethylbenzenesulfonamide

Literature searching skills are of special value in organic chemistry, which is an experimental science with a large literature. The preparative organic chemist's training is grounded in theory, but in practice he or she often relies less on a connected body of ideas than on his or her knowledge of specific reaction mechanisms, laboratory practice, and the special knack of finding information in scientific literature. In this respect the chemist's "practice" is like that of the trial lawyer, immersed in case law and requiring a sound knowledge of how to find his/her way around in a professional literature. In this workbook we will concern ourselves with the skills of finding the literature of experimental organic chemistry -- especially preparations.

A synthetic problem usually assumes that we wish to prepare a specific substance, though the synthesis may take more than one step and involve intermediates. If we are lucky, we will find a preparation in the literature. But if we cannot find such a synthesis, we may need to look for the preparation of a homologue (e.g., for benzamide, where we want p-toluamide), or an analogue (e.g., nicotinamide). If that approach fails, we will have to tax our chemistry harder to find a suitable "type reaction" that resembles what we wish to do. As an "introduction", however, this workbook deals mainly with preparations of specific substances.

Older preparations are often of value to students, because they use reagents that are safer and less expensive. This older literature, back into the Nineteenth Century, is covered much better in Beilstein than in Chemical Abstracts, and, as we shall see, once we find a synopsis for a compound in Beilstein, we can

scan the scholarship of a hundred years or more quickly, by going from one series to the others. Unlike CA, Beilstein assembles a great deal of material in one place, rather like an encyclopedia. We can usually decide from the information in the synopsis whether it is worth our time to pursue the original sources of information. Indeed, Beilstein may contain enough data in itself to satisfy our needs. It isn't necessary to read abstracts and then, still dubious, look up the original articles. For all of these reasons, where Beilstein is available to us, we seldom look first at recent issues of Chemical Abstracts. Instead, we start with Beilstein's Handbuch. CA is the end point of a search strategy; Beilstein is its beginning.

Students' fear of Beilstein (Beilsteinsangst) stems mainly from its use of German and its classified organization, which seems -- at first glance -- a deep mystery. Its use of German need be only a minor inconvenience, even to American students, because one usually needs to translate only a few phrases at most, and the library is adequately supplied with German-English dictionaries. Copies of the Beilstein Dictionary are kept at the desk for our use. The literature references, just as with Chemical Abstracts, cover an international literature. And as far as numerical data are concerned, a compound melts at the same temperature in German as it does in English.

Beilsteins Handbuch

Beilstein Contents

"Beilstein" is a nick-name for Beilsteins Handbuch der organischen Chemie, the most comprehensive and useful reference handbook in organic chemistry. All mention of Beilstein in this workbook refers to the 4th edition, which began publication in 1918. The fourth edition comprises five sets of volumes: a main set and four supplements:

Set	German Name	Abbreviation	Literature of the Period	Color Key
Main Set	Hauptwerk	H	to 1909	Green
Supplement I	Erganzungswerk I	EI	1910-19	Red
Supplement II	Erganzungswerk II	EII	1920-29	White
Supplement III	Erganzungswerk III	EIII	1930-49	Blue
Supplement IV	Erganzungswerk IV	EIV	1950-59	Blue
Suppl. III/IV*	Erganzung. III/IV	EIII/IV	1930-59	Blue & Black

*Notice that parts of EIII and EIV (volumes 17-27: heterocyclic compounds) were combined. This was done to speed up the slow appearance of EIII. EIV is not yet complete.

Beilstein uses an approach to organizing its material that we may call compound-oriented. It gathers information about specific chemical substances into short, information-dense synopses. A typical Beilstein synopsis provides:

*The index name and other names in bold type.
*The Hill formula
*Usually, a structural formula
*References to any earlier Beilstein locations for the same substance.
*Preparations, formations, occurence, and isolation
*Physical properties, such as, melting pt.(range), boiling pt., specific rotation, spectral values, solubilities, etc.
*Chemical properties
*Analytical methods
*Salts and complexes; And much more . . . .

This information has been evaluated according to high editorial standards, and Beilstein always provides references to the original research literature.

In order to pack so much information into so little space, Beilstein makes use of many standard (German) abbreviations, with which you will become familiar quickly. The key to these abbreviations is at the begining of each volume. The key to the journal title references is also at the beginning of each volume.

The Beilstein Classification System

We can locate a compound of interest to us in Beilstein by:

1. Using the formula and substance indexes, or
2. Finding it by recognizing its place in Beilstein's classification system.

For most searches it is practical to use the indexes, which we will examine in a moment. But effective use of the handbook calls for familiarity with the classification scheme. In some searches it is difficult or impossible to use the indexes unless we can anticipate the volume in which a compound should appear. So let us take a brief look at the classified organization.

Beilstein defines certain "stems" by a basic backbone chain or ring. These stems are subdivided by functional groups into "parent" compounds. Functional group modifications and other derivatives are listed after the parent index compounds. This is familiar stuff: we have seen a similar scheme in Chemical Abstracts Chemical Substances Index. But here the order of entry of compounds is hierarchical & classified rather than alphabetical. This is the hierarchy:

Division: based on the "stem" or molecular skeleton of a parent.
Subdivision: applies to hetero atoms of heterocyclic compounds.
Class: defined by the presence of functional groups.
Subclass: the number of functional groups or certain characteristic atoms present.
Rubric: degree of saturation of carbon bonds.
Series: the number of carbon atoms.
Individual: distinct substances (including non-functional derivatives).

We need discuss briefly only the divisions, subdivisions and classes.

Beilstein recognizes three divisions:

Division I: Acyclic stems -- open chains
Division II: Isocyclic stems -- carbon rings
Division III: Heterocyclic stems -- rings containing any N, O or other group 6a element.
(Division IV: Natural Products, used only in the Hauptwerk)

Division III, Heterocyclic Stems, is further classified into subdivisions, according to the number and type of hetero atoms in the ring:

Rings with one O (or other group 6a, "chalcogen") atom
" " two Os or other group 6a atoms
" " three or more Os or other group 6a atoms
Rings with one N atom
Rings with two N atoms
Rings with three or more N atoms
Rings with one N and one O or equivalent
Rings with one N and two Os or equivalents
Rings with two Ns and one O or equivalent
Rings with two Ns and two Os or equivalents; Etc. . . .

Divisions and subdivisions are further defined into classes, according to functional group substitutions of the stem. (Non-functional substitutions, such as halides and nitro groups, are not considered classes; they are treated as simple derivatives of the parent index compound). The classes include the following:

Unsubstituted stems
Hydroxy compounds
Carbonyl groups
Carboxylic acids and their derivatives (amides, esters, etc.)

This information has been evaluated according to high editorial standards, and Beilstein always provides references to the original research literature.

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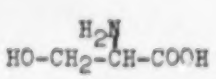
Sulfinic acids and their derivatives
Sulfonic acids and their derivatives
Acids of Se and Te and their derivatives
Amines
Hydroxyamines
Hydrazines
Azo compounds (-N=NH)
Other Nitrogen compounds
Compounds in which carbon in bonded to group 4a-1a atoms
Compounds in which carbon is bonded covalently to metals

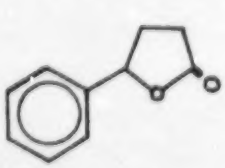
Ambiguities and incompleteness in the system of classification as we have described it so far, are met by the application of two rules to the analysis of chemical structures:

1. The Principle of Latest Possible Entry

This rule tells us that if a compound can be regarded as belonging to more than one class, Beilstein will assign it to the place that comes latest in the classification scheme. Consider, for example, the common amino acid, serine, which exhibits three functional groups:



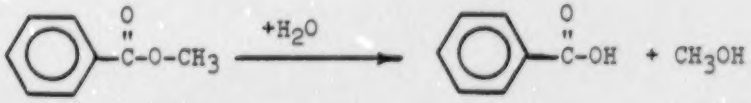
Should we consider serine a hydroxy compound, an amine or a carboxylic acid? The answer is that Beilstein puts it into the amine class, because of the principle of latest entry. Amines follow both the hydroxy and carboxylic acid classes in the scheme above. (How would CA treat it? If in doubt, how would you find out?) Similarly, will the following compound appear in Division II (isocyclic) or Division III (heterocyclic)?



According to the principle of latest possible entry, the answer is Division III. We considered it a phenyl derivative of the lactone.

2. Formal Hydrolysis:

Many compounds can be considered functional derivatives of a "parent" compound, and Beilstein indexes them after the parent, in the same part of the classification scheme. We saw earlier that Chemical Abstracts uses this same approach. To determine the functional parent (or possible parents) we may carry out a hypothetical ("formal") hydrolysis to the free functional groups. For example:

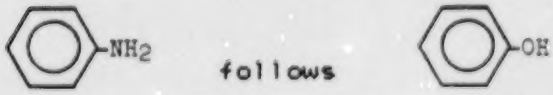


benzoic acid is the parent index compound of this ester. Sometimes more than route of hydrolysis is conceivable. In such cases, the route that leads to a parent compound described in the latest possible hypothetical entry is the right approach:

This route:

Not this route:

Because:



aniline phenol

Tertiary and secondary amines are considered hydrolyzable to primary amines and alcohols, as in this example, and ethers are considered hydrolyzable to alcohols. But cyclic compounds, such as lactones and cyclic anhydrides and imides, are treated as heterocyclic rings and formal hydrolysis, which would lead to acyclic stem parents, placed earlier in the classification, is not applied to them. By the way, "formal" hydrolysis disregards how easy or difficult it is to perform such a procedure in the laboratory.

The volume numbering system is consistent throughout the main set and all of the supplements. The same class(es) of compounds always appear in the same volumes. In the Hauptwerk one volume corresponds to one physical book. But in the First and Second Supplements more than one volume (Band) may appear in one binding, and in the Third and Fourth Supplements, a volume almost always appears in several separate parts (Teile).

Now we may summarize the contents of Beilstein by volume in a tabular form:

CONTENTS OF THE 27 VOLUMES OF BEILSTEIN*

Beilstein Index Compound	Structural Feature of Functional Group	I Acyclic Compounds	II Isocyclic Compounds	III Heterocyclic Compounds (by no. & type of hetero atoms)					
				1 O	2 O 3 O more Os	1N	2N	3N, 4N, more Ns	1N & 1O 1N & 2 Os 2Ns & 1 O 2Ns & 2 Os...Etc.
No functional group	--	1	5	17	18	20	23	25	27
Hydroxy compounds	-OH		6						
Oxo compounds	=O		7			21	24		
	=O + -OH		8						
Carboxylic acids	-OH	2	9						
	-OH (+ -OH; =O, or =O & -OH)	3	10						
Sulfinic acids	$-SO_2H$	4	11						
Sulfonic acids	$-SO_3H$								
Seleninic, Selenonic & Tellurinic Acids	$-SeO_2H$, $-SeO_3H$, TeO_2H								
Amines	$-NH_2$		12						
	$-NH_2$ + -OH		13						
	$-NH_2$ + other groups		14						

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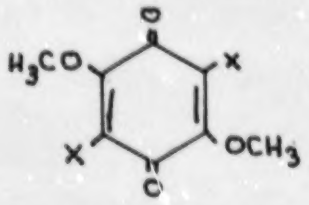
CONTENTS OF THE 27 VOLUMES OF BEILSTEIN*

Beilstein Index Compound	Structural Feature of Functional Group	I Acyclic Compounds	II Isocyclic Compounds	III Heterocyclic Compounds (by no. & type of hetero atoms)					
				1 O	2 O, 3 O, more Os	1N	2N	3N, 4N, more Ns	1N & 1 O 1N & 2 Os 2Ns & 1 O 2Ns & 2 Os ...Etc
Hydroxylamines & Dihydroxyl amines	-NH-OH $-N(OH)_2$		15						
Hydrazines	$-NH-NH_2$								
Azo compounds	-N=NH								
Diazonium salts	$-N\equiv N^+$								
Compounds with groups of three or more Ns	e.g.: $-NH-NH-NH_2$	4	16	18	19	22	25	26	27
Compounds with C bonded to group 5a elements (other than N)	e.g.: P,As,Sb,Bi.								
Compounds with C bonded to group 4a elements	e.g.: Si,Ge, Sn.								
Compounds with C bonded to group 3a-1a elements (except H)	e.g.: B,Al, ... Be,Mg,... Li,Na,...								
Compounds with C bonded to other metal atoms	e.g.: Fe,Cu,Ni,Pt...								

* Adapted from a poster provided by Springer-Verlag

1. In what Beilstein volume would you expect to find a compound with the following structure (assume that X is <u>any</u> non-functional group or element: H, alkyl, Br, Cl, NO , etc.)?



ANSWER:_____

1a. Explain your answer.

ANSWER: _____

_____

_____

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The Beilstein Indexes

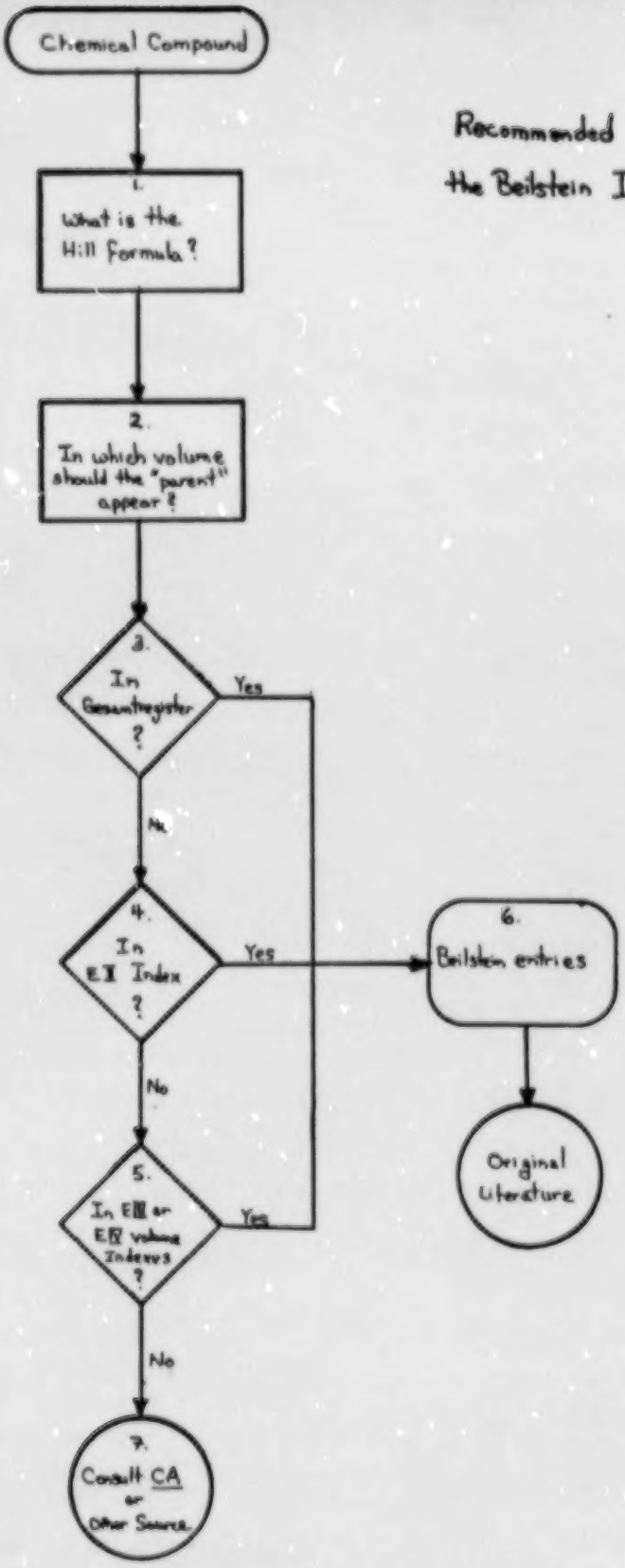
Beilstein supplies two types of indexes, which we use for the great majority of searches. They are, the Formula Index (Formelregister) and the Substance-name Index (Sachsregister, literally, "Subject Index"). The Substance-name Indexes pose some difficulty for native speakers of English, because the compound names are, of course, in German and may be strange to you. H through EII use trivial names. EIII and EIV use IUPAC names, but in their German form! So generally, we prefer to use the Formula Indexes, which give molecular formulas written in the familar Hill system (except for the index to H, which uses the older Richter system, but can safely be ignored). The useful indexes are as follows:

1. Comprehensive Index (Gesamtregister) -- appears at the end of the Beilstein sets and bears green bands on the spines. It is still in the progress of being published and will not be complete for several years. As of spring 1984 the published parts cover volumes 1-6 and 17-25. To use it effectively we should anticipate the volume in which the parent is apt to appear.

2. Index to EII -- The Second Supplement (volumes 28-29) contains a single comprehensive index for H-EII. It can provide an easy approach to the contents of these volumes. Then, by using the page numbers of the Hauptwerk as a key, as we will see shortly, we can find any references in EIII or EIV quickly.

3. Volume Indexes to EIII and EIV -- each part of each volume is separately indexed. We need to be able to anticipate not only which volume a compound will appear in, but also which part of the volume. As we shall see, this is often not as difficult as it sounds.

Recommended Strategy for the Beilstein Indexes



Finding all of the References

Once we find a compound in one of the Beilstein series, we can locate any other references in other series quite easily. Entries in <u>later</u> supplements will refer back, in parentheses, to entries in any <u>earlier</u> series. For example, in EIII/IV for indole-3-acetic acid we see:

> Indol-3-yl-essigsäure, Heteroauxin $C_{10}H_9NO_2$ Formel IV (H66; EI, 508; EII, 50)

These are page references to the <u>same volume</u> of H, EI and EII.

Searching <u>forward</u> from the Hauptwerk or earlier supplements <u>to later</u> references is almost as easy, because all of the supplements have header notes that give the corresponding pagination of the Hauptwerk. <u>The volume and page number of the Hauptwerk always serve as search keys</u>. For example, for indole-3-acetic acid, in volume 22, at the top of page 1673 of EIII/IV we see such a page reference to the corresponding place in the Hauptwerk, where the compound can be found:

EIII/IV 22		1673
	Syst. Nr. 3285 / H 66	

Hauptwerk page

The exact form of these Hauptwerk page references vary slightly, but they appear consistently through all of the Supplements.

To repeat, once we have located one Beilstein reference, any others -- earlier or later -- are easy to find by means of the references at the top of the Supplement pages to the corresponding Hauptwerk page, or by retrospective references in parentheses.

2. Find all of the Beilstein references (H to EIV) for _____ 4,4,4-trichlorobutene-2-amide _____ List them.

ANSWER: _____

2a. What is the melting point (or range) of this compound?

ANSWER: _____

2b. Give a <u>full bibliographic reference</u> (full journal title, authors, date, volume, pages) for a preparation of the compound.

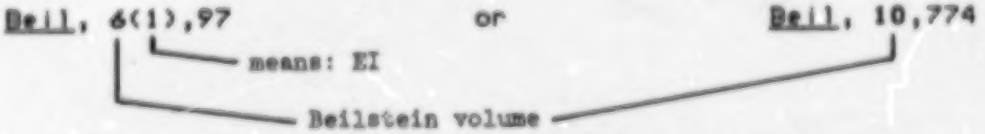
_____

_____

_____

Crutches for Beilstein Users

Beilstein's authority is so great that some lesser handbooks commonly provide references to it. These can be useful in locating a compound, or at least a closely related compound to provide the right volume number. One such source is the Aldrich Catalog of Fine Chemicals, which sits on most every chemist's bookshelf. It may have different uses for the scholar and the student. If the chemist finds a reagent in the catalog, he usually expects to buy it, but the student may use the same catalog's references as a shortcut into Beilstein, Organic Syntheses and other sources. The Aldrich Catalog gives not only prices for the reagent chemicals that Aldrich sells, but for many of them it also provides data and some literature references, including Beilstein citations. A Beilstein citation in The Aldrich Catalog looks like this:



You may have already discovered that The Aldrich Catalog also provides melting or boiling points and references to spectra in The Aldrich Library of IR Spectra and The Aldrich Library of NMR Spectra, both of which are kept on the index table shelves. Another handbook "crutch" is the CRC Handbook of Chemistry and Physics, which provides Beilstein references for most substances in the "Physical Constants of Organic Compounds" section. Typical CRC citations look like this:

B^{9^3}, 360

which means, Volume 9, EIII, page 360.

Other (English Language) Handbooks

In a happy turn of phrase, Professor White calls these handbooks "poor-person's Beilsteins". There is a variety of such handbooks, none of which is as comprehensive or authoritative as Beilstein, so we stand less chance of finding a specific compound in any one of them. But they are found in most libraries, and their great virtue is that English makes them admittedly easier to use than Beilstein. From among the growing number of such handbooks, we may look at two of them in particular.

Organic Syntheses (New York: Wiley, 1921 --)

This useful series began shortly after World War I. Before that time, Germany provided most of the fine chemicals used in research, but the war interrupted supplies to the U.S., so American chemists decided that they needed a compendium of useful preparations. From about 1960, as reagent chemicals have become easy to buy from suppliers like Aldrich, Organic Syntheses has become more selective in its coverage, choosing to include mostly interesting "type reactions".

For the years 1921-1969, the editors have revised and re-compiled the contents of the annual volumes of Organic Synthesis into Collective Volumes:

Collective Volume	Annual Volumes	Years
I	1-9	1921-29
II	10-19	1930-39
III	20-29	1940-49
IV	30-39	1950-59
V	40-49	1960-69
--	50--	1970--

The Collective Volumes contain new material, and we should always consult them in preference to the annual volumes. There is a Collective Index(1976) to Collective Volumes I-V, which offers multiple modes of access:

Title(i.e., chemical) Name
Type of Reaction
Type of Compound
Formula Index (Hill)
Solvents & Reagents
Apparatus
Authors
Cumulative General Index (includes reaction intermediates)

The preparations in Organic Synthesis are developed from current research publications and provide references to the original papers. They describe the procedures in clarity and detail, including quantities of reactants, apparatus, expected yields, methods of purification and characterization. If you find the preparation that you need here, consider yourself lucky.

Dictionary of Organic Compounds, 5th. ed., 7 vols. + supplements (London: Chapman & Hall, 1982--)

You encountered this reference handbook in the first semester. About 55,000 substances are mentioned in the DOC. This may seem a considerable number, but it is, in fact about 1% of the over 5 million organic substances known. And many of these 55,000 compounds receive only brief mention as "derivatives", subsumed under entries for "parent" compounds. Even the most ambitious handbooks cannot replace your responsibility to look at original journal literature.

The DOC gives bibliographic references to journal literature for preparations and data. The journal title abbreviations use the

Chemical Abstracts form. Entries also contain name synonyms, structual formulas, molecular formulas, molecular weights, melting points, specific rotations, hazard alerts, toxicological references, derivatives, etc. The list of references cited in the DOC does not come close to being as complete as Beilstein, and the preparations chosen for mention are not always the best.

Entry names are those by which, in the opinion of the editors, compounds are "most likely to be known" by chemists. In fact, though many names are IUPAC, they are a quite unpredictable melange. The DOC provides several indexes. The Molecular Formula Index (Hill) is the most useful. The Name Index contains the synonyms and names of all of the derivatives.

****

We may mention briefly a few more handbooks, without attempting to explain in any detail how they are used :

Comprehensive Organic Chemistry, ed. Derek Barton and W. David Ollis, 6 vols. Oxford: Pergamon, 1979. This treatise is most often used by synthetic chemists in search of experimental conditions to match their preparative schemes (For example, it is trickier to form a Grignard reagent in a flask than on paper). The organization of COC is by functional groups. This feature and its myriad of literature references make it a useful aid.

Organic Reactions New York: Wiley, 1942 --. An annual serial. Each volume contains several lengthy reviews -- each of a "type" reaction (e.g., Aldol Condensation) with wide applications, especially in preparative chemistry. These reviews have many literature references.

Reagents for Organic Synthesis, ed. Louis F. Fieser and Mary Fieser. New York: Wiley, 1967 --. The emphasis in "Fieser and Fieser" is on reactive materials of use in organic synthesis, rather than on the products. For each, the editors provide physical data, methods of preparation and purification, hazards, and, especially, preparative uses.

Synthetic Methods or Organic Chemistry, ed. Wilhelm Theilheimer. Basel: Krager, 1946 --. "Theilheimer", as it is commonly called, is a series of yearbooks that report new

synthetic methods and improved methods that have appeared in the literature. Theilheimer uses a unique set of symbols to indicate types of reactions and where bonds are formed or broken. It is designed to be searched for specific types of reactions and not for particular products. To use it effectively, you must have a projected synthetic path in mind. The abstracts are brief, so it is usually necessary to consult the original reference.

Some textbooks also have value as minor "treatises". Two worthy of mention are Arthur I. Vogel, A Textbook of Practical Organic Chemistry , 3rd. ed. London & New York: Longmans, 1956 and Jerry March, Advanced Organic Chemistry, 2nd ed. New York: Mcgraw-Hill, 1977.

3. What is the meaning of this reference in the Aldrich Catalog?

Beil. 9(3)2262

ANSWER: _____

4. Find a preparation for 3-thiophenecarboxylic acid in the Collective Volumes of Organic Syntheses. Give the volume and page numbers.

ANSWER: _____

4a. How many preparations for it (count them) are cited in the footnotes of the Organic Syntheses article?

ANSWER: _____

5. Give a bibliographic reference for the first paper cited in the Dictionary of Organic Compounds for a synthesis (synth) of _____ 1-H-indole-3-acetic acid

ANSWER: _____

_____

Preparations in Chemical Abstracts

Until the end of EIII (i.e., till 1949), Beilstein does a competent job of referencing preparations. For the oldest literature it is superior to Chemical Abstracts. But EIV is still in progress, and its coverage of recent literature is more selective. So, if we fail to find a useful preparation in Beilstein (and other handboooks), we may turn to CA. The 5th Decennial Index (1947-56) offers a practical starting point, from which we can work forward.

In an earlier workbook we talked about the problems of chemical names in CA, and we need not repeat that discussion here. Remember that chemical substances appear in the Subjects Index through the Eighth Collective Period (to 1971), but in the Chemical Substances Index from 1972 on. You may also use the Formula Index to find the CA name of a compound, but use that name only as an entry to the Subjects or Chemical Substances indexes, because the Formula Index has no descriptive "text modification" phrases to indicate which papers are about preparations:

Formula Index ⟶ Subjects or Chemical Substances Indexes

Recent years of Chemical Abstracts (from 1967 --) will indicate articles on preparations in one of two ways. If the compound is very common, or the object of much interest, so that CA has several pages of entries for it, certain standard subheadings will apply (analysis, biological studies, occurence, etc.). These apppear in bold type, in alphabetical order. One of them is "preparation":

Benzaldehyde[100-52-7], preparation

Such common reagents as these we would usually buy, rather than make. Most "preparations" listed for them will be patents. But if the substance is less well-studied, there will be no need for subheadings. In that case, if several abstract references are provided, any that appear first, <u>with no descriptive "text modification" phrase</u>, will usually be preparations:

Benzaldehyde, ...
_____, 4,bromo [1122-91-4] 80:14306t; 81:12152v; 83: P 205988p
acetalation of, with . . . .

Notice that the last paper abstracted in this example is a patent. In general, patents are dead ends for our purposes here, because the claims in them are often not clear or descriptive from a chemist's perspective, and UVM does not receive them.

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6. Give a standard bibliographic reference (see the example below) for the first citation in the Ninth Collective Index of CA for a preparation of 2,4-dinitrophenol

ANSWER: _____

_____

_____

6a. Give a similar reference for the first citation in the Ninth Collective Index for a preparation of 4-ethylbenzenesulfonamide

_____

ANSWER: _____

_____

_____

Bibliographic reference form:

W.N. White and J.R. Klink, J. Org. Chem. 1977, 42(1), 166-9.

REFERENCES

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STUDENT EVALUATION

1. What was the level of difficulty of these exercises (circle one):

   a. too easy
   b. about right for me
   c. too difficult

2. Approximately how many hours did you spend on the workbook?:

3. How useful was the experience of the workbook for your understanding of Beilstein, Organic Syntheses, and the other handbooks? (Please comment):

4. What parts of the workbook were particularly helpful? (Please comment):

5. What parts were least helpful?: (Please comment):

6. Do you expect that the experience of the workbook will be of help in your "project" or in the identification of your unknowns?